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EXPLORATORY STUDY PLAN

CHEMICAL CONTROL OF THE BLACK TURPENTINE BEETLE, DENDROCTONUS TEREBRANS (OLIV.), IN NAVAL STORES TIMBER

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CHEMICAL CONTROL OF THE BLACK TURPENTINE BEETLE, DENDROCTONUS TEREBRANS (OLIV.), IN NAVAL STORES TIMBER

By Wm. H. Bennett

This exploratory study is being undertaken to probe for new angles of old problems, with untried chemicals and formulations, so that a well designed formal study can be set up in early 1963.

The Problem

Formerly considered of little importance, the black turpentine beetle, Dendroctonus terebrans (Oliv.), has in recent years become the costliest and most troublesome forest insect in the Midsouth. The insect is especially troublesome following logging operations, but it is becoming increasingly destructive in the expanding turpentine production program in the Gulf States.

A 1.0 percent gamma isomer benzene hexachloride (BHC) solution in No. 2 diesel oil, when thoroughly applied to infested bark, will effectively control beetle broods, and prevent further attack for at least 7 months. However, when the formulation is applied to turpentine-faced trees or to trees prior to chipping, gum production is reported to be greatly reduced for a period of about a month. As a consequence, naval stores operators are reluctant to use this method of control.

The current high cost of control in relation to naval stores values at stake precludes the protective treatment of all gum trees in a crop. Most operators, therefore, are interested in spraying trees only when they become infested and for the dual purpose of arresting brood development and preventing further attack for as long a period as possible. The immediate problem then is to find a suitable chemical formulation that will control the beetle without adversely affecting gum production.

Literature Review

The literature on the black turpentine beetle has been reviewed by Thatcher (10, 11) and later by Bennett (1).

Research to determine methods of controlling the beetle in living trees was started in 1950. Earlier studies (3) had demonstrated that a 0.25 percent solution of gamma isomer BHC in No. 2 fuel oil would protect green logs from attack by various beetle species, but nothing was known about the effect of the insecticide on the turpentine beetle. J. F. Coyne was the first to attempt chemical treatment of infested trees, but his studies showed that the 0.25 percent solution killed beetle broods too slowly to prevent tree mortality in severe infestations (4).

Smith (5, 6, 8) in subsequent years tested BHC and other insecticides against the beetle as a preventive measure and further developed remedial control. Solutions of 0.5 percent gamma BHC, 1 percent heptachlor, 5.0 percent DDT, and 2.0 percent aldrin each in No. 2 diesel oil were tested as a preventive measure. BHC and aldrin were far superior to all others, giving 96 and 95 percent protection, respectively, for a 7-month period. Diesel oil alone provided 26 percent protection. For several reasons BHC was chosen as being better than aldrin.

A 0.5 percent gamma aqueous emulsion was also tested, but only 69 percent protection was obtained over the 7-month period.

In remedial control studies, Smith found that 0.5 percent gamma BHC in diesel oil would kill 75 to 80 percent of the established broods. Later tests showed that 95 percent control could be obtained by increasing the gamma concentration to 1.0 percent. Such a formulation is recommended for controlling the turpentine beetle in the thick-bark slash pine of the Southeast. A 0.5 percent solution is considered adequate as a control measure in the Midsouth.

Objectives and Scope

There are three general objectives to the study:

1. To verify the assumption that No. 2 diesel oil and not BHC is the cause of retarded gum flow, and to determine for how long and to what extent gum production is reduced following treatment.

2. To find a suitable substitute for diesel oil, as a carrier for BHC, that will not adversely affect gum production and that, in combination with BHC, will offer a high degree of remedial and preventive control.

3. To develop a BHC aqueous emulsion formulation with an extender or other additive(s) that will provide effective remedial and/or preventive control.

Results of the exploratory study should form a basis for a formal research plan in the calendar year 1963. The objective of the plan will be to test the BHC-"new carrier" solution and an aqueous emulsion formulation as a means of preventive control. The emulsion will include a suitable extender and possibly a film coating agent to help prolong the residual action of the insecticide.

Study plots for 1963 will be randomized and located on poorly-drained sites where beetle populations are known to be high. Sprays will be applied to the basal portion of standing trees that are to be cut approximately 2, 4, and 6 months after treatment. Following cutting, stumps in each plot will be examined for beetle attack and the degree of protection determined by comparison to untreated stumps in check plots.

Ultimately a suitable preventive spray may be developed that can be safely and economically applied to naval stores stands prior to chipping. Such a formulation will be of value in gum stands where beetle populations are large or where severe infestations are expected.

General Methods - 1962 Tests

Test 1. To determine whether BHC or diesel oil is the cause of reduced gum flow. The butt portion of chipped trees in one plot will be sprayed with diesel oil and the same number of chipped trees in two adjacent plots will be sprayed with a BHC aqueous emulsion and a BHC oil solution, respectively. The total production in each of the two plots will be compared with the total production in an unsprayed, similarly worked check plot. Measurements will be made at bi-weekly intervals until adverse effects of the treatments are no longer apparent.

Should the BHC aqueous emulsion cause an appreciable reduction in gum flow, further tests will be made using the emulsifying agent or the solvent alone.

Test 2. To find a suitable carrier for BHC that will replace No. 2 diesel oil but that will not reduce gum production. A non-phytotoxic oil, such as a white oil, or other diluent that is believed to be less toxic

to bark tissue than is diesel oil, will be applied to chipped trees in test plots. Total gum production in each test plot will be compared to that in an unsprayed, similarly worked check plot at bi-weekly intervals to determine adverse effects, if any.

Test 3. To test the effectiveness of 1.0 and 2.0 percent BHC aqueous emulsions in destroying beetle broods. Infested stumps in two plots will be sprayed with the two formulations and their effectiveness as a control compared to untreated stumps in an adjacent plot.

Test 4. To determine the adequacy of a 1.0 percent BHC aqueous emulsion, with different extenders, in destroying beetle broods. Two or more 1.0 percent BHC emulsion sprays, each containing a different extender, will be applied to infested stumps in adjacent plots. The effectiveness of control in each test plot will be obtained by comparison to an untreated check plot and to a plot treated with 1.0 percent BHC emulsion alone.

Test 5. To discover the value of a diluent from Test 2, as a 1.0 percent BHC solution, in controlling beetle broods. Treated and untreated infested stumps in adjacent plots will be compared to determine the effectiveness of the spray for remedial control.

Detailed Instructions Covering Operations

Spray material will be applied with garden-type or back-pack sprayers to thoroughly soak the bark and bark crevices to the point of runoff, or roughly at the rate of one gallon of spray to 50 square feet of bark. In tests involving insecticides, BHC concentrate or emulsifiable concentrate, containing one pound of gamma isomer per gallon, will be used in solution or emulsion, respectively.

Tests 1 and 2. There will be 5 plots (possibly 6 as indicated below) in these tests, each consisting of 20 first-year chipped trees. The plots will be adjacent to each other on similar sites and the test trees will be of near equal diameter and crown development. If possible, the trees will be free from beetle attack.

The trees will be marked with plastic flagging, using a different color for each plot. The bands will be tied firmly and as high as possible around the trunk to facilitate detection and to discourage removal by cattle. Trees in Plot 1 will be marked with red flagging; in Plot 2 with blue; in Plot 3 with orange; in Plot 4 with yellow; and in Plot 5 with white.

Soon after operators have removed the gum from cups on the marked trees (preferably the same or following day), trees in the plots under test will be sprayed. The spray will be applied to the entire surface of the trunk, including the chipped area, from a height of one foot above the area to be faced (as indicated by the removal of outer bark) to the ground.

Marked trees in Plot 1 will be sprayed with No. 2 diesel oil; in Plot 2 with 1.0 percent BHC aqueous emulsion; in Plot 3 with a 1.0 percent BHC oil solution; and in Plot 4 with a non-phytotoxic oil. Plot 5 will receive no treatment and will serve as a check. If another diluent for BHC is available (one that is considered non-toxic to tree tissues), it will be tested in Plot 6, using a blue and white flagging.

The 1.0 percent BHC aqueous emulsion will be prepared by thoroughly mixing 1 gallon of BHC emulsifiable concentrate in 12 gallons of water,

and the 1.0 percent BHC oil solution will be prepared by thoroughly mixing 1 gallon of BHC emulsifiable concentrate in 12 gallons of No. 2 diesel oil.

Following treatment, it is expected that gum flow in Plots 1 and 3 will be reduced for about a month. At bi-weekly intervals following treatment, the gum collected in each test plot will be measured by total volume or weight, whichever is the more practical, and compared to the total cuppage in the check plot. This procedure will be continued until gum production in Plots 1 and 3 (and possibly in other test plots) approximates that of the check plot.

Gum reduction will be expressed in percent as follows:

$$\frac{\text{Total production in check plot - Total production in test plot}}{\text{Total production in check plot}} \times 100$$

Tests 3 and 4. There will be 5 plots in these tests each consisting of 20 infested stumps (as heavily infested as possible), preferably with broods in the mid-larval stage. The plots will be adjacent to each other and as similar as possible with respect to diameter of stumps, infestation, and exposure to the elements. The stumps in each plot will be marked on the top surface with paint, using the appropriate plot number.

Prior to spraying the test stumps, litter will be raked away from the root collar for a distance of 6 inches to expose the soil. Sprays will be applied to the entire bark surface and from the top of the stump to the base. An extra pass with the spray stream will be made around the root-collar area to soak the soil.

Marked stumps in Plot 1 will be sprayed with 1.0 percent BHC aqueous emulsion, prepared by thoroughly mixing at the rate of 1 gallon of BHC emulsifiable concentrate in 12 gallons of water.

Marked stumps in Plot 2 will be sprayed with 2.0 percent BHC aqueous emulsion, prepared by thoroughly mixing at the rate of 2 gallons of BHC emulsifiable concentrate in 12 gallons of water.

Marked stumps in Plot 3 will be sprayed with 1.0 percent BHC aqueous emulsion plus Aroclor 4465, prepared by thoroughly mixing at the rate of 1 gallon of BHC emulsifiable concentrate and 1 pound of Aroclor in 12 gallons of water.

Marked stumps in Plot 4 will be sprayed with 1.0 percent BHC aqueous emulsion plus Aroclor 5460, prepared by thoroughly mixing at the rate of 1 gallon of BHC emulsifiable concentrate and 1 pound of Aroclor in 12 gallons of water.

Marked stumps in Plot 5 will not be sprayed nor the litter from around them raked. They will serve as checks.

Following treatment, when broods are well advanced, the bark of all but 2 stumps in each of the 5 plots will be removed and insect survival calculated. The bark also will be removed from below ground to examine broods that have moved downwards from attacks above. In each plot the number of gallery systems containing living broods will be counted and totaled. Also, for each plot, the approximate number of dead and living larvae, pupae, parent adults, and young adults will be counted and recorded by stages, and the counts of dead and living individuals totaled.

The effectiveness of control based on both total-gallery survival and total-population survival in each plot will be obtained by either of the following formulae.

$$\text{Percent control} = \frac{\text{Total survival in check} - \text{Total survival in test}}{\text{Total survival in check}} \times 100$$

$$\text{Percent control} = \frac{\text{Percent dead in test} - \text{Percent dead in check}}{100 - \text{Percent dead in check}} \times 100$$

The two unpeeled stumps in each plot will be reserved for further study if control is less than 85 percent effective in any of the plots. In such plots, portable wire screen cages will be placed over the stumps, including the 2 in the check plot, with white sand covering the soil below. Following beetle emergence from the bark, brood survival will be determined, based on beetles collected in the cages.

Test 5. This test will be dependent upon a suitable diluent obtained in Test 2. There will be 2 plots, each consisting of 20 infested stumps (as heavily infested as possible, preferably with broods in the mid-larval stage). The plots will be adjacent to each other and as similar as possible with respect to stump size, degree of infestation, and exposure to the elements.

The stumps in each plot will be marked on the top surface with paint, using the appropriate plot number.

Litter from around the base of marked stumps in Plot 1 will be raked away for a distance of 6 inches to expose the soil. The entire bark surface, from the top of the stump to the ground will be sprayed with a 1.0 percent BHC solution that does not adversely affect gum production. The solution will be prepared by thoroughly mixing in the proportion of 1 gallon of BHC concentrate in 12 gallons of diluent. An extra pass with the spray stream will be made around the root collar to soak the soil.

Raking and spraying will not be done in Plot 2, which will serve as a check.

Following treatment, when broods are well advanced, the bark of all but 2 stumps in each plot will be removed and insect survival calculated in the same manner as in Tests 3 and 4.

Installation and Location

The study plots for Tests 1 and 2 will be established in naval stores areas on industrial or State lands in the vicinity of Oakdale or Woodworth, Louisiana, and spraying will be completed by July 1.

Study plots for Tests 3 and 4 will be installed in cutting areas on the Kisatchie National Forest, and treatment will be completed by July 15.

The establishment of plots in Test 5 will be dependent upon positive results from Test 2, and will probably be in July or later. The test will be made in cutting areas on the Kisatchie National Forest.

Miscellaneous

Presentation of Results and Date of Completion

Establishment reports will be prepared as spraying is completed in each phase of the study.

A final report on the exploratory study will be prepared in the fall of 1962.

Results of the tests will serve as a basis for a formal study in 1963.

Personnel Assignment

Bennett will be responsible for preparation of plans, reports, and compilation of data and, with Stein, will establish plots, conduct tests, make observations, and record results.

Cooperation

The Kisatchie National Forest will provide test plots in logging areas. Industry and the Louisiana Forestry Commission will provide study areas in naval stores stands. Chemicals will be contributed by insecticide manufacturers.

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